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Testing Laboratory
Toxics Use Reduction Case Study
Mercury Discharge Reduced

Summary

Under a compliance mandate from the Massachusetts Water Resources Authority (MWRA), a 250-employee testing laboratory reduced its mercury discharges from 0.3 mg/L to less than 0.001 mg/L. This reduction was achieved through a two-pronged approach: source reduction techniques were used to reduce the amount of mercury entering the company's wastewater treatment system by approximately 90%; a more sophisticated treatment system was then installed to remove the residual mercury. The changes permitted the company to meet mercury emissions standards several months ahead of MWRA's compliance deadline. The Office of Technical Assistance (OTA) provided confidential help with the project.

Background

In mid-1992, MWRA gave the company a December 31, 1993, deadline for eliminating mercury from its wastewater discharges. The Authority prohibits mercury discharges into its system, meaning that the laboratory's discharge had to be brought below 0.001 mg/L.

The source of the mercury in the company's wastewater was found to be thimerosal, a mercury salicylate salt that is used as a bacteriostat/fungistat in many test kits and cannot be readily replaced. Test kit manufacturers, aware of the problem and under pressure from their customers, are working to develop reagents with alternative preservatives. However, the removal of mercury from a test kit involves revalidation of the test kit with subsequent approval by the FDA. This is a time-consuming process that can require several years to complete.

Source Reduction Efforts

Having determined that thimerosal was the source of the mercury, the company undertook a program to identify which analytical instruments' wastewater discharges contained mercury. Samples from all point-of-source discharges were sent to an environmental testing laboratory for mercury quantification. Approximately 50 potential sources were identified and tested. About 30% of the sources were found to contain measurable quantities of mercury, some as high as 1.0 mg/L.

Once these analyses were complete, a number of source reduction efforts (toxics use reduction and wastewater sequestering) were implemented to prevent mercury from entering the wastewater. The primary toxics use reduction (TUR) technique was to contact test kit manufacturers to determine the availability of suitable mercury-free alternatives. Some manufacturers, including Technicon and Hybritech, were already aware of the mercury issue and were able to supply alternative kits. Others, however, indicated that revalidation of reformulated kits would take a minimum of two years. This effort resulted in the replacement of four of the 15 test kits used by the company after validation studies were performed (a 1 to 2 month process).

At OTA's prompting, the company pursued several other TUR options, including worker training and improved housekeeping techniques, in order to prevent mercury from entering the facility's wastewater. All employees were informed of the problem and the efforts being taken to correct it. Signs and labels are now posted throughout the facility describing the proper handling and disposal of mercury-containing materials, with emphasis on what shouldn't be discharged down the drain. These efforts are particularly important since only a very small amount of mercury (about 0.2 grams) is needed to raise mercury concentrations in the wastewater to 0.3 mg/L.

Finally, about five gallons/day of wastewater is sequestered at the source and transported off-site as hazardous waste. This consists of all equipment discharges containing mercury that can be easily collected at the source in small pails. While this is not a large volume of water, it does account for many of the instrument discharges containing high concentrations of mercury.

As a result of these source reduction efforts, the mercury level in the wastewater discharge was reduced to about 0.03 mg/L. Although this represented a significant reduction in mercury concentration, it was not sufficient to comply with the MWRA requirement. Consequently, the company investigated several additional measures, including additional sequestering (up to and including the entire facility discharge) and on-site wastewater treatment. The treatment options explored included evaporation, ion exchange, precipitation and carbon adsorption. Based on an economic analysis of the various approaches, carbon adsorption was chosen as the most cost effective technique.

Wastewater Treatment

A pilot study was conducted to determine the effectiveness of carbon adsorption. In this test, about 450 gallons/day of wastewater were treated using Disposorb carbon. This is a reactivated carbon sold by Calgon in plastic drums. When the carbon bed is saturated, the entire drum is sent off-site for disposal. During testing, carbon adsorption was found to be effective in removing mercury; mercury levels were reduced from 0.06 mg/L upstream of the carbon bed to non-detectable levels in the effluent of the bed. Based on these results, the company decided to treat approximately 1,800 gallons per day of wastewater in a carbon adsorption system. The system consisted of three parallel trains of carbon beds, with each train comprised of two drums of Disposorb carbon in series. Substantial replumbing of the facility wastewater system was required in order to treat the entire laboratory wastestream. The system was effective in removing mercury, but only to a concentration of approximately 0.02 mg/L, well above the compliance level required by MWRA. The company also noted extensive bacterial growth on the carbon beds.

At this point, the company asked OTA for assistance with the adsorption system. Following a site visit, OTA prepared a number of recommendations intended to optimize system performance:

- Operate the system with constant optimum flowrates through the carbon beds by using an equalization tank upstream of the carbon beds to provide storage capacity and pumps. The system had been installed without any provision for control of flow rates, and this was resulting in channeling in the beds, which led in turn to poor mercury removal. OTA suggested that the company contact Calgon to determine optimal flow rates.

- Install bag filters upstream of the carbon beds to avoid plugging the carbon with solids, which decreases the adsorptive capacity of the carbon.

- Investigate the use of an ultraviolet (UV) light or silver-impregnated carbon to control bacterial growth in the carbon adsorption system. (Silver is a bacteriostatic material, i.e. it inhibits bacterial growth).

Based on these recommendations, the company installed a 500-gallon equalization tank upstream of the carbon beds and flow control valves on each of the three trains to maintain optimum flow through the carbon beds. The valves were sized based on information supplied by Calgon. Calgon also indicated that the adsorptive capacity of the carbon is greatest when the pH of the water is maintained between 4.0 and 5.0. The pH of the influent to the system is now adjusted to this range in the equalization tank. Bag filters (15 micron size) were added upstream of

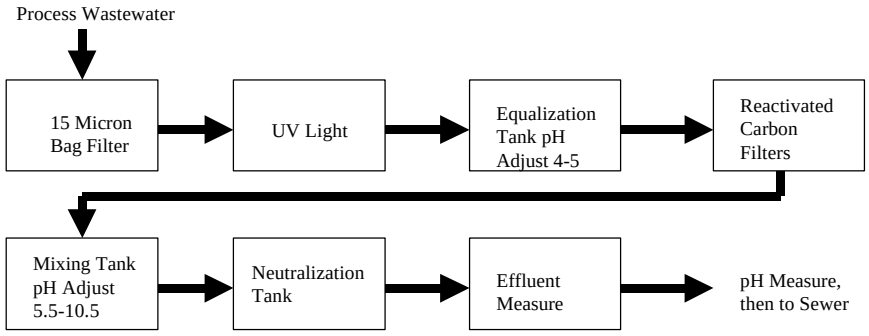
the equalization tank, and ultraviolet lights were installed between the filters and the equalization tank to control bacterial growth. The pH of the effluent from the carbon system is adjusted to the range of 5.5 to 10.5 before it flows into the existing neutralization tank. A schematic of the wastewater treatment system is shown in Figure 1.

Results

Reductions: Once these changes were made, effluent mercury levels of less than 0.001 mg/L were achieved. The company successfully completed the required compliance testing in the fall of 1993, several months prior to the MWRA deadline. While toxics use reduction efforts were not themselves sufficient to achieve compliance, they did lead to a 90% reduction in the amount of mercury that must be removed in the treatment system. This translates into lower treatment system costs.

Economics: Capital expenditures to achieve compliance were in excess of $60,000. This included both the pilot and full-scale carbon adsorption systems, and replumbing the facility. According to company calculations, the monthly operating costs of the new system are $7,665. The company would have been exposed to fines of $10,000 per day if it had not met the MWRA deadline for elimination of mercury effluents.

Figure 1: Schematic of Wastewater Treatment System



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